Federally-Funded Information Technologies

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Director, National Coordination Office for Information Technology Research and Development

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Information Technology is one of the key factors driving progress in the 21st century

Information Technology is transforming the way we:

- Communicate
- Deal with information
- Learn
- Practice health care
- Conduct commerce
- Work
- Design and build things
- Conduct Research
- Deal with the Environment
- Conduct Government

Information technology is creating a new infrastructure for business, scientific research, and social interaction

The Federal government plays a critical role in supporting fundamental IT R&D

- **Federally-sponsored research has helped build the technology base on which the computing industry has grown.**
- **Fundamental research is key to stimulating innovation, and innovation is key to continued U.S. leadership in IT.**
- **Federal research funding complements, rather than preempts private research investments:**
  - The benefits of fundamental research are generally too distant and too uncertain to receive significant industry support.
- **Federal funding for research plays a critical role in educating students in the computing field.**

Government/Industry Roles in IT R&D

- **Federal investments support long-range fundamental research that industry cannot sustain**
  - High risk, innovative ideas whose practical benefits may take years to demonstrate
  - Directly support the education of the IT workforce professionals

- **The industrial R&D investment, though large in dollars, is different in nature:**
  - Research is focused on short-term – over 90% of IT R&D expenditures are for product development – typically 18 months product life cycle

Information Technology – An Essential National Interest

Past Federal investments have yielded spectacular returns

- The Internet, the first graphical Web browser, advanced microprocessors
- IT now accounts for one-third of U.S. economic growth and employs 7.4 million Americans
- Business-to-consumer e-commerce is projected to grow to $1.8 billion by 2002 (ITAA)
- The Internet has faster household penetration than telephone or television: 50 million Americans in five years
- Over 200 million people connected to Internet world-wide and is expected to reach 1 billion by 2005

We have an essential national interest in ensuring a continued flow of good new ideas and trained professionals in information technology

Aggressive IT R&D is essential for achieving 21st century aspirations

- Improved quality and delivery of health care
- Safer and cheaper transportation by air, land, and sea
- Improved climate models to support more informed decisions
- More efficient and responsive government
- Better quality and delivery of education and training to all Americans
- Stronger national security
- A safer and improved environment through efficient design and operation of buildings, vehicles, and equipment
- Better warnings of dangerous weather
- Increased productivity of research in all disciplines
- Faster response to hazardous materials releases
- Decreased reliance on untested and insecure information systems

Opportunities for innovation in IT are large – and becoming even more important

History of The Federal HPCC Initiative (HPC Act of 1991, P.L. 102-194)

- Chartered by Congress FY 1992 through FY 1996 with the High Performance Computing Act of 1991
- Focused on:
  - High Performance Computing Systems
  - Advanced Software Technology and Algorithms
  - National Research and Educational Network
  - Information Infrastructure Technology and Applications
  - Basic Research and Human Resources
- Was coordinated through the High Performance Computing, Communications, and Information Technology (HPCCIT) Subcommittee and NCO

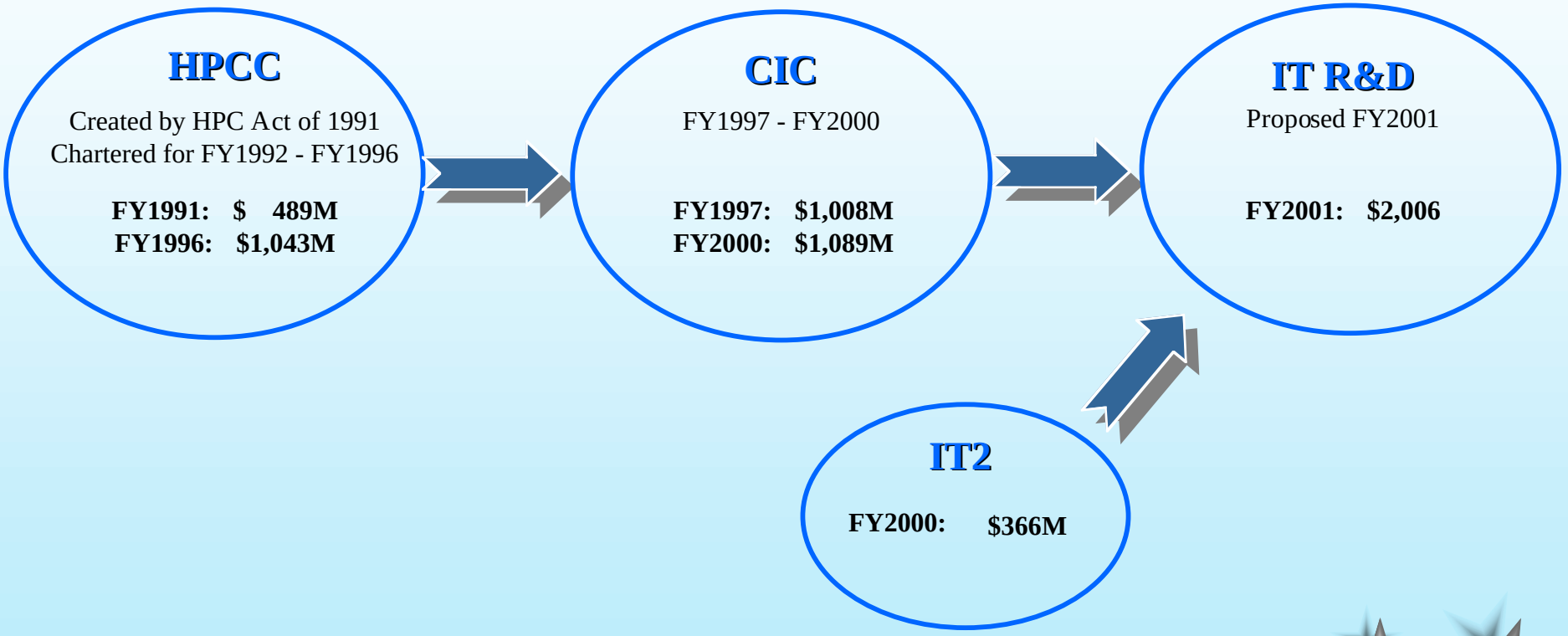
HPCC Program Goals

- Extend U.S. technological leadership in high performance computing and computer communications.
- Provide wide dissemination and applications of these technologies to speed the pace of innovation and improve national economic competitiveness, national security, education, health care, and the global environment.
- Provide key enabling technologies for the National Information Infrastructure (NII) and demonstrate select NII applications.

Federal HPCC Program Contributions

- Scalable parallel systems
- Enabling technologies for workstations, distributed systems
- Microkernel operating systems
- Internet networking technology
- Information infrastructure, including early WWW browsers
- Research for Digital Libraries
- Gigabit testbeds
- Supercomputer Centers
- Grand Challenge Applications
- National Challenge Applications
- Mission applications: e.g., national security, medicine, environment, and education

From HPCC to IT R&D



Information Technology R&D Program

- Evolved from the Federal HPCC and CIC
- Provides a mechanism for focused long-term interagency R&D in information technologies.
- $2 billion multi-agency Information Technology R&D Program
  - 11 agencies and departments coordinated via a “virtual agency” coordination/management structure
  - Coordinated by the National Coordination Office for Information Technology Research and Development
- Assessed by the President’s Information Technology Advisory Committee.
- Includes the Next Generation Internet initiative and the Information Technology for the 21st Century (IT^2) program.

Participating Agencies and Departments

- Defense Advanced Research Projects Agency (DARPA)
- National Science Foundation (NSF)
- Department of Energy (DoE)
- National Aeronautics and Space Administration (NASA)
- National Institutes of Health (NIH)
- National Security Agency (NSA)
- National Institute of Standards and Technology (NIST)
- Office of the Secretary of Defense/University Research Initiative (OSD/URI)
- National Oceanic and Atmospheric Administration (NOAA)
- Environmental Protection Agency (EPA)
- Agency for Health Care Policy and Research (AHCPR)

Coordination of IT R&D Programs

WHITE HOUSE

Executive Office of the President
Office of Science and Technology Policy

President's Information Technology Advisory Committee (PITAC)

U.S. Congress

IT R&D Authorization and Appropriations Legislation

National Science and Technology Council

Senior Principals Group for IT R&D

National Coordination Office (NCO) for Information Technology Research and Development

Interagency Working Group on Information Technology R&D

Participating Agencies: AHRQ, DARPA, DOE, EPA, NASA, NIH, NIST, NOAA, NSA, NSF, OSD/URI

- **High End Computing and Computation Coordinating Group (HECC)**
- **Large Scale Networking Coordinating Group (LSN)**
- **High Confidence Software and Systems Coordinating Group (HCSS)**
- **Human Computer Interface & Information Management Coordinating Group (HCI & IM)**
- **Software Design and Productivity Coordinating Group (SDP)**
- **Social, Economic and Workforce Implications of IT Coordinating Group (SEW)**
- **Federal Information Services and Applications Council (FISAC)**

President's Information Technology Advisory Committee (PITAC)

- **Top IT experts from the private sector and the research and education communities.**
- **24 members who guide the Administration's efforts to accelerate the development and adoption of information technologies.**
- ***Information Technology Research: Investing in Our Future***.
  - Recommended increasing strategic investments from $1.46 billion in FY 2000 to $2.83 billion in FY 2004.
  - Four priority areas for long-term R&D:
    - Software
    - High end computing
    - Scalable information infrastructure
    - Socioeconomic impact
- **In 2000, three panel reports were released:**
  - *Resolving the Digital Divide: Information, Access and Opportunity*
  - *Transforming Access to Government through Information Technology*
  - *Developing Open Source Software to Advance High End Computing*

PITAC Membership List

Co-Chairs

Raj Reddy, Ph.D. / **Carnegie Mellon University**

Irving Wladawsky-Berger, Ph.D. / **IBM Corporation**

Members

- Eric A. Benhamou, Ph.D. / **3Com Corporation**
- Vinton Cerf, Ph.D. / **WorldCom**
- Ching-chih Chen, Ph.D. / **Simmons College**
- David M. Cooper, Ph.D. **/ Lawrence Livermore National Laboratory**
- Steven D. Dorfman (retired) / **Hughes Electronics Corporation**
- David W. Dorman / **AT & T**
- Robert Ewald / **E-Stamp Corporation**
- Sherrilynne S. Fuller, Ph.D. / **University of Washington School of Medicine**
- Hector Garcia-Molina, Ph.D. / **Stanford University**
- Susan L. Graham, Ph.D. **/ University of California - Berkeley**
- James N. Gray, Ph.D. **/ Microsoft Research**
- W. Daniel Hillis, Ph.D. **/ Applied Minds, Inc.**
- Robert E. Kahn, Ph.D. **/ Corporation for National Research Initiatives (CNRI)**
- Ken Kennedy, Ph.D. **/ Rice University**
- John P. Miller, Ph.D. **/ Montana State University**
- David C. Nagel, Ph.D. **/ AT&T**
- Edward H. Shortliffe, M.D., Ph.D. **/ Columbia University**
- Larry Smarr, Ph.D. **/ University of California - San Diego**
- Joe F. Thompson, Ph.D. **/ Mississippi State University**
- Leslie Vadasz **/ Intel Corporation**
- Andrew J. Viterbi, Ph.D**. / The Viterbi Group**
- Steven J. Wallach **/ Chiaro Networks**

Coordination Management Structure: OSTP & NSTC

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- Advise the President and others within the Executive Office of the President on the impacts of science and technology on domestic and international affairs
- Works closely with the NCO Director and IWG Chair to coordinate the interagency IT R&D programs

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- Provides coordination, planning, budgeting, and review of multi-agency IT R&D programs
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- Coordinates planning activities with OSTP and budget activities with OMB
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- Membership consists of representatives from eleven agencies/departments, OSTP, and OMB
- Chaired by Ruzena Bajcsy, Ph.D. (NSF)

National Coordination Office for Information Technology Research and Development (NCO)

- **Director of NCO reports to the Director of OSTP.**
- **Coordinates Federal multiagency information technology (IT) research and development (R&D) programs.**
  - High Performance Computing and Communications (HPPC)
  - Next Generation Internet (NGI)
  - Information Technology for the 21st Century (IT^2)
- **Supports the six Program Component Areas (PCAs) that report to the IWG for IT R&D**.
- **PITAC coordination**

IT R&D Coordinating Groups

- **Six Program Component Areas (PCAs)**
  - High End Computing and Computation (HECC)
  - Large Scale Networking (LSN)
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  - Each PCA includes hardware, software, algorithms, and applications
  - Each PCA focuses on specific R&D goals, ensures adequate investments, and maintains necessary budget visibility
  - Technology R&D may span PCAs
  - Applications span PCAs

IT R&D Program Component Areas (PCAs)

High End Computing and Computation (HECC)	• State of the art in computing systems, applications, and high end infrastructure • Advanced architectures • Mass storage
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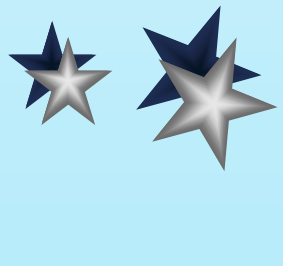
High Confidence Software & Systems (HCSS)	• System reliability -- “no surprise software” • Security and privacy
Human Computer Interaction & Information Management (HCI & IM)	• Knowledge repositories and information agents • Collaboratories • Systems to enable multi-modal human-system interactions • Virtual reality environments
Software Design and Productivity (SDP)	• Software engineering of complex systems • Active software • Component-based software design • Networked embedded systems
Social, Economic and Workforce Implications of IT and IT Workforce Development (SEW)	• Application of interdisciplinary research • Curriculum development, fellowships, and scholarships • R&D in information-based learning tools, lifelong learning, and distance learning



Agency IT R&D Budgets by PCA

FY 2001 Budget Request (dollars in millions)

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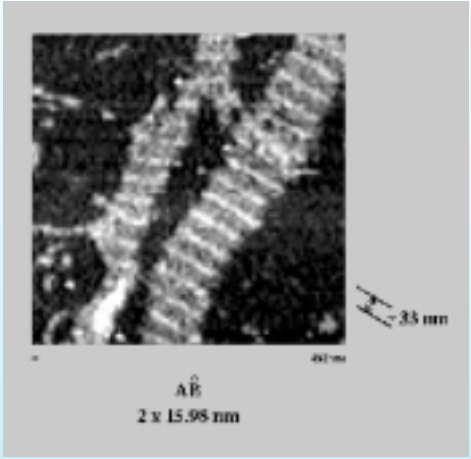
DARPA	111.1	48	85.3	55	8	0	307
NASA	154.9	17.9	19.5	20	9.1	8.3	230
NIH	37.9	99.6	65.6	.7	6.5	7	217
DOE	136.5	16.6	32	0	0	4.6	190
NSA	32.9	0	1.9	0	44.7	0	80
NIST	3.5	6.2	4.2	2	8.5	0	24
NOAA	15.1	.5	2.7	1.5	0	0	20
AHRQ	0	8.1	7.4	0	0	0	16
OSD/URI	2	2	4	1	1	0	10
EPA	3.6	0	0	.6	0	0	4
Subtotal	***884.7***	***334.7***	***333.8***	***120.3***	***98.3***	***65.2***	***1,838***
DOE ASCI	168.3	0	35	40.2	0	55.7	299
Totals	1,053	334.7	368.8	160.5	98.3	120.9	2,137

Research Highlights

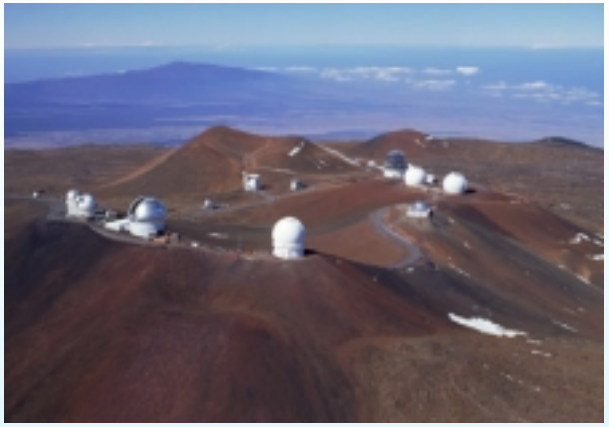
- **Quantum Computing** -- Research to develop a "quantum computer" that can solve certain problems asymptotically more rapidly than conventional computers. The NSA has several projects underway and in FY 2000, a consortium of university and Government laboratories is working on a scalable silicon-based nuclear spin quantum computer concept.



- **DNA Data Storage** -- One gram of DNA contains 1021 DNA bases, which is equal to 108 terabytes of information storage. A DARPA- and NSF-funded project is leveraging recombinant DNA techniques-appropriately modified to ensure error resiliency-to solve NP search problems. A key goal of DNA nanotechnology is construction of periodic arrays in 2 and 3 dimensions. The project has produced 2-D arrays from antiparallel double crossover molecules.

- **Sensor information technology (SensIT)** -- Microfabricated sensors will be a crucial part of decision-making in the battlefield, surveillance with minimal manpower, and maintenance of equipment. DARPA's sensor information technology (SensIT) program is dedicated to maximizing the useful information that a network of thousands of sensors can deliver to key decision-making points in a timely manner. SensIT's mission is to develop all necessary software for a networked system of inexpensive, pervasive platforms that combine multiple microsensors, embedded processors, positioning ability, and wireless communication.

Research Highlights

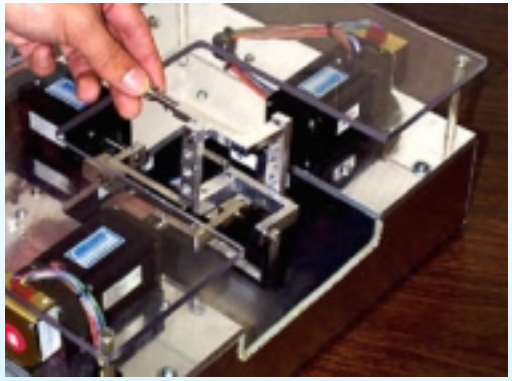


- **Remote observing** -- A new remote observing application will provide authorized scientists anywhere on an NGI network with access to the more than $1 billion in research instruments at the Mauna Kea Observatories in Hawaii. The cloud-free, dry, and stable atmosphere on Mauna Kea permits more detailed astronomical studies than are possible elsewhere.

- **Internet Protocol security (IPsec)** -- NIST's IPsec research develops scalable technologies and tools to make the IP--the basic software framework enabling the routing and flow of Internet message traffic--more secure. IPsec enables a centrally controlled access policy and a multilevel security approach to provide security services including data origin authentication, connectionless integrity, replay protection, data confidentiality, limited traffic flow confidentiality, and key negotiation and management.

- **Adaptive learning technology** -- DoD researchers are developing geographically distributed, cost-efficient, versatile, reusable, and adaptable systems to meet education and training goals for DoD's military and civilian workforces--technologies that can be deployed wherever and whenever the need arises. This includes research on human factors leading to the design of effective, efficient, and user-friendly training environments and many other issues.

Research Highlights



- **Human factors in aerospace systems** -- NASA's R&D in human factors will develop advanced human-centered information technology, models of human/system performance, principled methods for human factors design of human-centered computing systems, and human factors expertise to address aerospace challenges. NASA and the University of California-Berkeley have built haptic interfaces for arm-scale and finger-scale manipulation. Its workspace is one-third the scale of the arm device, enough to allow a full range of fingertip motion when engaged in a precision pinch grip with the wrist supported.

- **Education, Outreach and Training** -- NSF's PACI, comprising the National Computational Science Alliance and NPACI, sponsors joint education, outreach, and training (EOT-PACI) activities to bring PACI-developed high performance hardware capabilities and software learning tools to bear in classrooms at all levels of education and in government, and provide training for teachers and other professionals in uses of new technologies. A number of EOT-PACI efforts focus on outreach to women, minorities, and individuals with disabilities, through such means as Web resources, mentoring programs, and IT internships.

A Federal IT Success Story: The Internet

- **Internet started with DARPA - funded research to implement researcher-to-researcher exchanges of data (FTP) and text (HTML).**

- **Internet has expanded dramatically, particularly in response to the "next killer application"**
  - IP
  - Email
  - World Wide Web
  - Napster
  - What's next? You can't predict.

The Current Internet

The real issue is end-to-end performance for end users

- **Bandwidth is increasing dramatically**
  - Optical networking
  - Wave Division Multiplexing
  - Dense Wave Division Multiplexing
- **Efficiency of Bandwidth use is decreasing**
  - Increasing numbers of hops between end users
  - Application/Network Interfaces need tuning
- **Local area networks and local access are often bottlenecks. Technology is needed for:**
  - Remote access
  - Tether-free access
  - Increased bandwidth for end-user access

The Future of Networking

- **All optical networking**
  - Wave Division Multiplexing
  - Optical switches are under development using MEMS
  - End-to-end optical is needed for end-user performance
- **Networks to support distributed computing: GRID**
- **Sensor nets (billions of embedded sensors, online)**
- **Collaboratories with security, quality of service and high assurance**
- **New applications**
- **Wireless systems and services**
- **Computer-computer communication**
  - Network attached storage, agents, distributed data bases, distributed computing
- **Practical voice command**

Next Generation Internet Initiative Explores Tomorrow's Networks and Applications

- Presidential Initiative begun 1998
- Approximately $100M per year
- Six agencies funded directly
  - DARPA, NSF, DOE, NASA, NIH, NTIA
- Several other agencies collaborating
- Cooperating with university-based Internet 2 program
- See www.ccic.gov, www.ngi.gov and www.internet2.org

Goals of Next Generation Internet Initiative

- **Conduct research in next generation networking technologies to add functionality and improve performance.**

- **Develop a Next Generation Internet testbed,emphasizing end-to-end performance, to support networking research and demonstrate new networking technologies.**
  - 178 NGI sites have been established -- universities, Federal research institutions, and other research partners -- at speeds 100 times faster than today's Internet (**100X**)
  - 15 sites have been established at speeds 1,000 times faster than the current Internet (**1000X**)

- **Over 200 NGI applications have been documented that meet important national goals and missions and that rely on the advances made in goals 1 and 2.**

Examples of Industry Involvement

- **Federal agencies contract with the commercial sector for research and development**
  - Web 100: Intel, Sun and others are developing an automatically tuned application/network interface. All optical networking: Ciena and others are developing key optical networking components.

- **Federal agencies purchase network services with commercial providers giving the providers direct experience with high-performance networking. Providers contribute significant services and equipment (value is many times the Federal contribution)**
  - vBNS network (NSF) is provided by MCIWorldcom
  - DREN is provided by AT&T
  - ESnet is provided by Qwest
  - NREN is provided by Sprint

Industry Involvement (Cont.)

- Commercial sector participates directly in Federally funded testbeds, e.g. Quality of Service Backbone network (Qbone) participants include NASA, NSF, DoD, Internet2, Cisco, Spirent, Torrent/Ericsson and Nortel. The commercial sector provides services and equipment for testing.

- The commercial sector participates in the Joint Engineering Team (JET) that architects the NGI: Cisco, Qwest and MCIWorldcom.

PITAC Review and Impact of NGI

- **PITAC annually reviews the NGI Program.**
- **Findings:**
  - The NGI Program has made excellent progress
  - "More applications should be funded that demonstrate the utility of the NGI's gigabit bandwidth to end-users, its increased security, and its expanded quality of service"
  - Federal agencies should provide more capability to measure network performance
  - **Congress should consider additional funding for a program where the NGI research institutions act as aggregators and mentors for nearby smaller or disadvantaged institutions.**
- **Impact:**
  - PITAC findings contributed to continued funding of NGI
  - Federal agencies significantly increased the funding of NGI applications
  - NGI agencies funded performance measurement of NGI networks
  - NGI agencies funded Educause to assist smaller institutions in taking advantage of high performance networking

Types of Industry Involvement

- CRADAS
- Collaboration
- IPAS
- Consortia
- Start-ups
- Tech Transfer
- Procurement
- Standards Development
- Advisory Committees . . . .

Discussion of Program Prospects:
The Future of the NCO and the IWG for IT R&D

Compelling Reasons for Coordination & Continued IT R&D Funding

- Coordination is important for leveraging Federal research across agencies, ensuring there is no duplication of effort, and identifying research gaps.
- IT is a growing component of the U.S. economy and IT leadership will be critical in the 21st century.
- Past Government-funded IT R&D has yielded huge economic return on investment, and continues its pivotal role in promoting innovation.
- IT is beneficial to a wide range of important national goals.
- The Internet and the information infrastructure must become more capable to support tomorrow's applications.
- As our economy and society increasingly depend on IT, we must be able to design information systems that are more reliable and more secure.
- Increased bandwidth will become increasingly important, but it must be end-to-end bandwidth.
- IT will revolutionize our national science and engineering R&D strategy.
- Funding research will help the intellectual base grow, thereby ensuring continued innovation.

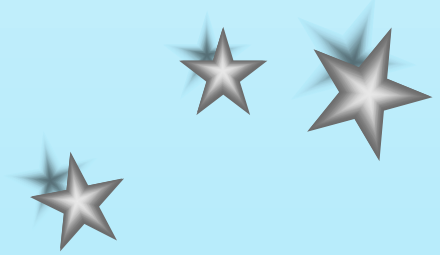
For Further Information on Federally Funded IT R&D

Contact us at:

National Coordination Office for
Information Technology Research and Development
4201 Wilson Boulevard, Suite II- 405
Arlington, VA 22230
(703) 292-4873 (ITRD)
nco@itrd.gov

Visit our Web Sites:

www.itrd.gov
www.ngi.gov



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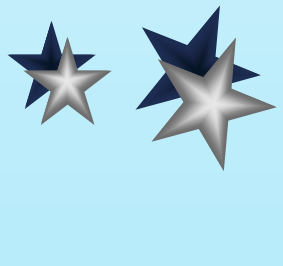

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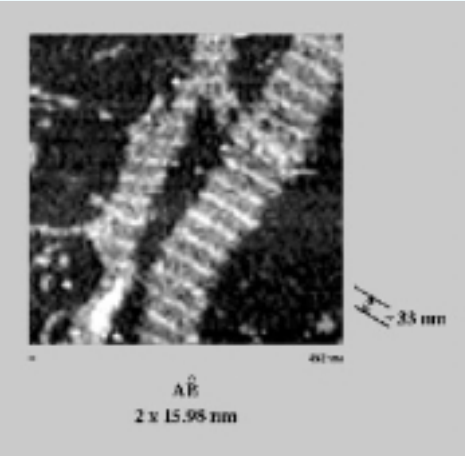
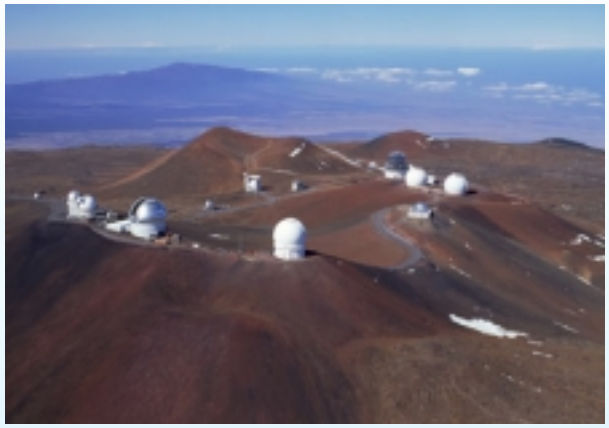
- **Quantum Computing** -- Research to develop a "quantum computer" that can solve certain problems asymptotically more rapidly than conventional computers. The NSA has several projects underway and in FY 2000, a consortium of university and Government laboratories is working on a scalable silicon-based nuclear spin quantum computer concept.



- **DNA Data Storage** -- One gram of DNA contains 1021 DNA bases, which is equal to 108 terabytes of information storage. A DARPA- and NSF-funded project is leveraging recombinant DNA techniques-appropriately modified to ensure error resiliency-to solve NP search problems. A key goal of DNA nanotechnology is construction of periodic arrays in 2 and 3 dimensions. The project has produced 2-D arrays from antiparallel double crossover molecules.

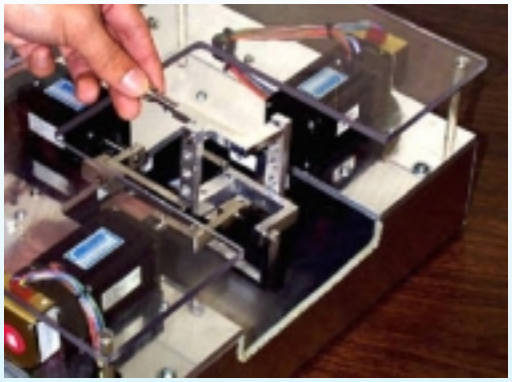
- **Sensor information technology (SensIT)** -- Microfabricated sensors will be a crucial part of decision-making in the battlefield, surveillance with minimal manpower, and maintenance of equipment. DARPA's sensor information technology (SensIT) program is dedicated to maximizing the useful information that a network of thousands of sensors can deliver to key decision-making points in a timely manner. SensIT's mission is to develop all necessary software for a networked system of inexpensive, pervasive platforms that combine multiple microsensors, embedded processors, positioning ability, and wireless communication.

Research Highlights



- **Remote observing** -- A new remote observing application will provide authorized scientists anywhere on an NGI network with access to the more than $1 billion in research instruments at the Mauna Kea Observatories in Hawaii. The cloud-free, dry, and stable atmosphere on Mauna Kea permits more detailed astronomical studies than are possible elsewhere.
- **Internet Protocol security (IPsec)** -- NIST's IPsec research develops scalable technologies and tools to make the IP--the basic software framework enabling the routing and flow of Internet message traffic--more secure. IPsec enables a centrally controlled access policy and a multilevel security approach to provide security services including data origin authentication, connectionless integrity, replay protection, data confidentiality, limited traffic flow confidentiality, and key negotiation and management.
- **Adaptive learning technology** -- DoD researchers are developing geographically distributed, cost-efficient, versatile, reusable, and adaptable systems to meet education and training goals for DoD's military and civilian workforces--technologies that can be deployed wherever and whenever the need arises. This includes research on human factors leading to the design of effective, efficient, and user-friendly training environments and many other issues.

Research Highlights



- **Human factors in aerospace systems** -- NASA's R&D in human factors will develop advanced human-centered information technology, models of human/system performance, principled methods for human factors design of human-centered computing systems, and human factors expertise to address aerospace challenges. NASA and the University of California-Berkeley have built haptic interfaces for arm-scale and finger-scale manipulation. Its workspace is one-third the scale of the arm device, enough to allow a full range of fingertip motion when engaged in a precision pinch grip with the wrist supported.

- **Education, Outreach and Training** -- NSF's PACI, comprising the National Computational Science Alliance and NPACI, sponsors joint education, outreach, and training (EOT-PACI) activities to bring PACI-developed high performance hardware capabilities and software learning tools to bear in classrooms at all levels of education and in government, and provide training for teachers and other professionals in uses of new technologies. A number of EOT-PACI efforts focus on outreach to women, minorities, and individuals with disabilities, through such means as Web resources, mentoring programs, and IT internships.

A Federal IT Success Story: The Internet

- **Internet started with DARPA - funded research to implement researcher-to-researcher exchanges of data (FTP) and text (HTML).**

- **Internet has expanded dramatically, particularly in response to the "next killer application"**
  - IP
  - Email
  - World Wide Web
  - Napster
  - What's next? You can't predict.

The Current Internet

The real issue is end-to-end performance for end users

- **Bandwidth is increasing dramatically**
  - Optical networking
  - Wave Division Multiplexing
  - Dense Wave Division Multiplexing
- **Efficiency of Bandwidth use is decreasing**
  - Increasing numbers of hops between end users
  - Application/Network Interfaces need tuning
- **Local area networks and local access are often bottlenecks. Technology is needed for:**
  - Remote access
  - Tether-free access
  - Increased bandwidth for end-user access

The Future of Networking

- **All optical networking**
  - Wave Division Multiplexing
  - Optical switches are under development using MEMS
  - End-to-end optical is needed for end-user performance
- **Networks to support distributed computing: GRID**
- **Sensor nets (billions of embedded sensors, online)**
- **Collaboratories with security, quality of service and high assurance**
- **New applications**
- **Wireless systems and services**
- **Computer-computer communication**
  - Network attached storage, agents, distributed data bases, distributed computing
- **Practical voice command**

Next Generation Internet Initiative Explores Tomorrow's Networks and Applications

- Presidential Initiative begun 1998
- Approximately $100M per year
- Six agencies funded directly
  - DARPA, NSF, DOE, NASA, NIH, NTIA
- Several other agencies collaborating
- Cooperating with university-based Internet 2 program
- See www.ccic.gov, www.ngi.gov and www.internet2.org

Goals of Next Generation Internet Initiative

- **Conduct research in next generation networking technologies to add functionality and improve performance.**

- **Develop a Next Generation Internet testbed,emphasizing end-to-end performance, to support networking research and demonstrate new networking technologies.**
  - 178 NGI sites have been established -- universities, Federal research institutions, and other research partners -- at speeds 100 times faster than today's Internet (**100X**)
  - 15 sites have been established at speeds 1,000 times faster than the current Internet (**1000X**)

- **Over 200 NGI applications have been documented that meet important national goals and missions and that rely on the advances made in goals 1 and 2.**

Examples of Industry Involvement

- **Federal agencies contract with the commercial sector for research and development**
  - Web 100: Intel, Sun and others are developing an automatically tuned application/network interface. All optical networking: Ciena and others are developing key optical networking components.

- **Federal agencies purchase network services with commercial providers giving the providers direct experience with high-performance networking. Providers contribute significant services and equipment (value is many times the Federal contribution)**
  - vBNS network (NSF) is provided by MCIWorldcom
  - DREN is provided by AT&T
  - ESnet is provided by Qwest
  - NREN is provided by Sprint

Industry Involvement (Cont.)

- Commercial sector participates directly in Federally funded testbeds, e.g. Quality of Service Backbone network (Qbone) participants include NASA, NSF, DoD, Internet2, Cisco, Spirent, Torrent/Ericsson and Nortel. The commercial sector provides services and equipment for testing.

- The commercial sector participates in the Joint Engineering Team (JET) that architects the NGI: Cisco, Qwest and MCIWorldcom.

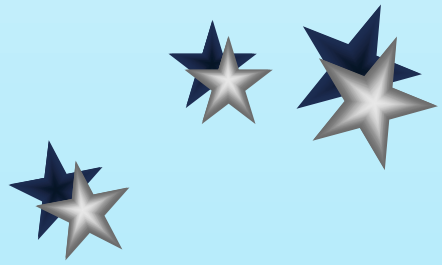
PITAC Review and Impact of NGI

- **PITAC annually reviews the NGI Program.**
- **Findings:**
  - The NGI Program has made excellent progress
  - "More applications should be funded that demonstrate the utility of the NGI's gigabit bandwidth to end-users, its increased security, and its expanded quality of service"
  - Federal agencies should provide more capability to measure network performance
  - **Congress should consider additional funding for a program where the NGI research institutions act as aggregators and mentors for nearby smaller or or disadvantaged institutions.**
- **Impact:**
  - PITAC findings contributed to continued funding of NGI
  - Federal agencies significantly increased the funding of NGI applications
  - NGI agencies funded performance measurement of NGI networks
  - NGI agencies funded Educause to assist smaller institutions in taking advantage of high performance networking

Types of Industry Involvement

- CRADAS
- Collaboration
- IPAS
- Consortia
- Start-ups
- Tech Transfer
- Procurement
- Standards Development
- Advisory Committees . . . .

Discussion of Program Prospects:
The Future of the NCO and the IWG for IT R&D



Compelling Reasons for Coordination & Continued IT R&D Funding

- Coordination is important for leveraging Federal research across agencies, ensuring there is no duplication of effort, and identifying research gaps.
- IT is a growing component of the U.S. economy and IT leadership will be critical in the 21st century.
- Past Government-funded IT R&D has yielded huge economic return on investment, and continues its pivotal role in promoting innovation.
- IT is beneficial to a wide range of important national goals.
- The Internet and the information infrastructure must become more capable to support tomorrow's applications.
- As our economy and society increasingly depend on IT, we must be able to design information systems that are more reliable and more secure.
- Increased bandwidth will become increasingly important, but it must be end-to-end bandwidth.
- IT will revolutionize our national science and engineering R&D strategy.
- Funding research will help the intellectual base grow, thereby ensuring continued innovation.

For Further Information on Federally Funded IT R&D

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